Chapter 24
Off-Gas Oxidation (Thermal/Catalytic)

24.1 General.

The process of off-gas oxidation is described in the first section of the chapter. The chapter's second portion is a hazard analysis with controls and control points listed.

24-2. Technology Description.

a. Process.

Off-gas oxidation is the incineration of contaminated air or other vapor streams in order to destroy the contaminants before discharge to the atmosphere. A vapor stream laden with volatile organic compounds (VOCs), produced by a soil vapor extraction (SVE) system or a landfill vent system, is blown through a duct system that contains an ignited burner within the duct fed by a fuel such as natural gas or propane. In the thermal application, the heat of the fuel combustion oxidizes the combustible components of the VOC stream in the duct, and the exhaust gas is sent to a stack for discharge. The system is designed to meet a temperature and residence time condition similar to an incinerator.

Catalytic oxidizer units use a precious metal catalyst on a support such as alumina, similar to those used in catalytic converters in automobiles. The function of the catalyst is to lower the required oxidation temperature of the system. The air or gas stream must still be heated but to a lower temperature that allows catalytic oxidation to occur. This saves fuel costs and can reduce the amount of off-gas treatment required (less NO_x is generated). The catalyst is poisoned by the same types of chemicals (lead, coke, and tar compounds) that reduce automotive catalytic system performance. If high concentrations of chlorinated solvents are present, the catalyst support and the duct work may require special construction to cope with the hydrogen chloride gas generated, and scrubbers may be required to remove the acid before the stream is exhausted. See Figure 24-1.

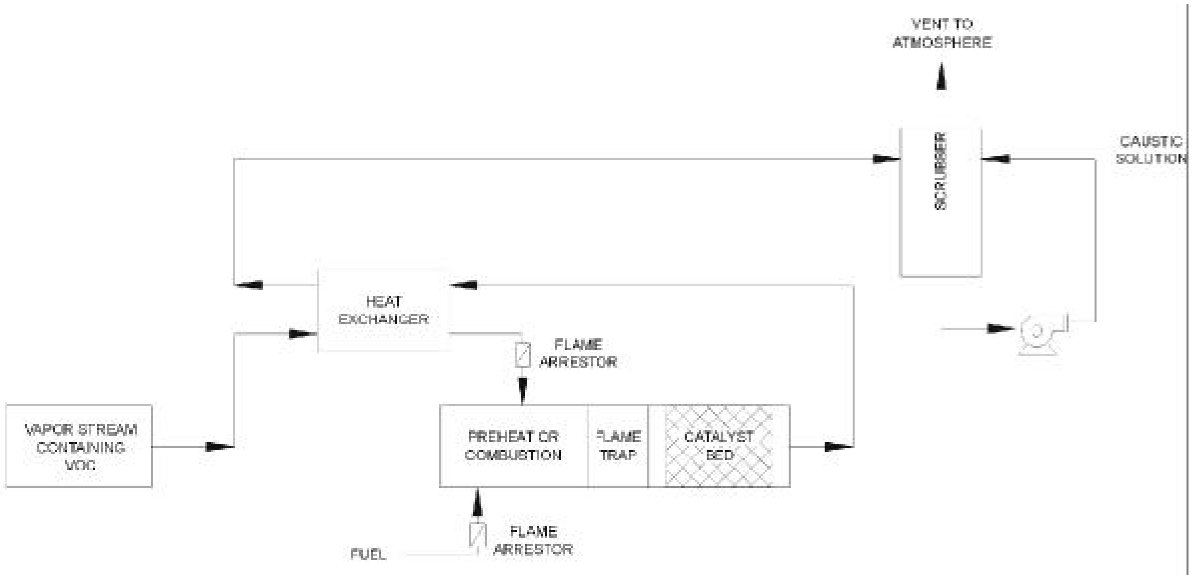

FIGURE 24-1. OFF-GAS OXIDATION (THERMAL/CATALYTIC)

24-3. Hazard Analysis.

Principal unique hazards associated with off-gas oxidation (thermal/catalytic), methods for control, and control points are described below.

a. Physical Hazards.

(1) Fire.
Description: If the BTU value of the waste feed is not controlled and higher than expected BTU value feed is fed into the unit, the temperature of the unit may exceed its design specifications, resulting in damage to the unit and increasing the probability of a release of waste material. Operating off-gas oxidizer systems above the design concentration or temperature may cause auto-ignition and a resulting fire hazard. High-BTU value feeds may generate a fire traveling back into the source.

Control: Controls for fire include

- Use experienced operators and supervisors.
- Audit and apply proper QA/QC to assure work is done as designed.
- Operate the system and waste feed within design parameters.

- Do not allow airflow to exceed the capacity of the system for efficient removal of solids.
- Do not allow temperatures in the primary combustion chamber to exceed 95 percent of the ash fusion temperature (as determined by ASTM E953) of the material being treated.
- Monitor and control the catalyst bed temperatures continuously.
- Incorporate flame traps and control valves into the design to prevent fires from igniting the source.

CONTROL POINT: Design, Operations, Maintenance

(2) Noise Hazards.
Description: Off-gas oxidation units may cause elevated noise levels in the work area due to the operation of air blowers, pumps, and the ignition of fuels within the combustion chamber.

Control: Controls for noise include

- Design and use baffles and insulation to control the transmission of noise.
- Establish a hearing protection program to determine necessary controls and use adequate hearing protection (see 29 CFR 1910.95).
- Use personal electronic communications devices to overcome the noise.
- Establish noise-free areas to provide breaks from the noise, which can cause fatigue and inattention.

CONTROL POINT: Design, Operations

(3) Flammable/Combustible Fuels.
Description: Off-gas oxidation usually requires storage of flammable fuels (e.g., propane or natural gas). Hazards associated with flammable/combustible fuels include the potential for an on-site spill or release of material. The release may cause worker exposure to the vapors generated, or a fire hazard may exist if the material is ignited.

Control: Controls for flammable/combustible fuels include

- Use appropriate tanks (equipped with pressure-relief devices and bermed) to help prevent release of material (see 29 CFR 1910.106).
- Locate tanks in an appropriate location on the site.

CONTROL POINT: Design, Construction, Maintenance

(4) Electrocution.
Description: Since off-gas oxidation units operate electrical systems outdoors, workers may be exposed to electrocution hazards.

Control: Controls for electrocution include

- Verify that drawings indicate the hazardous area classifications as defined in NFPA 70-500-1 through 500-10.

- Use controls, wiring, and equipment that meet the requirements of EM 385-1-1, Section 11.G and NFPA 70.
- Use grounded equipment or equipment with adequate ground-fault protection.

CONTROL POINT: Design, Construction, Operations, Maintenance

(5) Burn Hazards.
Description: Thermal oxidizers operate at high temperatures, which may result in thermal burns to workers.

Control: Controls for burns include
- Use temperature safety control systems to protect people and equipment.
- Use safety barriers to isolate critical sections of the equipment.
- Post signs warning of high temperatures.
- Use heat resistant gloves.

CONTROL POINT: Design, Operations, Maintenance

(6) Transfer Equipment Design.
Description: Improperly designed systems can corrode or dissolve to a point of failure and cause damage to people or the facilities. Workers may be seriously injured or killed under falling or collapsing equipment.

Control: Controls for transfer equipment include
- Use transfer equipment fabricated from materials that are chemically resistant to the chemical being transferred. Chemical resistance charts are available through the National Association of Corrosion Engineers (NACE).
- Consult Hydraulic Institute Standards HI 9.1-9.5 for appropriate materials for pumping various fluids.

CONTROL POINT: Design, Construction, Maintenance

(7) Explosion.
Description: Liquids can condense and collect in the piping systems, resulting in system over-pressurization and explosion.

Control: Controls for explosion include
- Install a knockout tank or drum to collect condensed liquids before they reach vacuum pumps, blowers, or the treatment unit.
- Use containment drip pans or receivers where leaks may occur.
- Install spill and/or leak detection instruments if necessary.
- Implement a routine process system inspection.

CONTROL POINT: Design, Operations, Maintenance

(8) Piping System Leaks.
Description: Workers may be exposed via the inhalation exposure route to a VOC, such as toluene, if leaks occur in the pressurized section of the piping system.

Control: Controls for leaks in the piping system include

- Design the system to operate under a negative pressure (e.g., ducts and piping) for the maximum operating pressure expected.
- Avoid or minimize fugitive emission hazards by designing pressure control mechanisms and appropriate relief systems.
- Install and test fuel systems according to requirements of NFPA 30 (Flammable and Combustible Liquids Code); NFPA 31 (Installation of Oil Burning Equipment); NFPA 54 (National Fuel Gas Code); or NFPA 58 (Standard for the Storage and Handling of Liquefied Petroleum Gases).

CONTROL POINT: Design, Operations, Maintenance

(9) Predesign Field Activities.
Description: Predesign field activities associated with subsequent construction activities may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminant groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, biological, or radiological hazards.

Control: Control for hazards resulting from predesign field activities include

- Prepare an activity hazard analysis for predesign field survey activities. EM 385-1-1, Section 1.A provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards.

(1) Equipment Entry.
Description: During maintenance and/or repair, workers entering the unit for cleaning, inspection, or repair of equipment may be exposed to waste materials or incomplete combustion byproducts as part of a confined-space entry. Workers may be exposed to an atmosphere containing toxic materials or to one that is oxygen deficient.

Control: Controls for equipment entry include

- Assess hazards at the time of confined-space entry (see 29 CFR 1910.146).

- Wear appropriate personal protective equipment (PPE) such as air-supplied respirator and disposable protective coveralls.

CONTROL POINT: Operations, Maintenance

(2) Toxic Material Exposure (Feed or Byproducts).
Description: During operation of the off-gas oxidation unit, workers may be exposed to waste components/toxic materials in the feed vapor; byproducts of incomplete combustion, such as carbon monoxide; or to airborne toxic materials, including metal acetates, mercury, and chlorine. In addition, toxic byproducts such as dibenzofurans and dioxins may also be generated during the process.

Control: Controls for exposure to toxic materials include
- Classify gaseous waste components prior to oxidation.
- Feed only gaseous waste streams compatible with the process into the unit.
- Note design parameters on feed characteristics. Select technology appropriate for the known or anticipated wastes.
- Train workers in potential exposure hazards and in appropriate PPE.

CONTROL POINT: Design, Operations

(3) Transfer Equipment Design.
Description: Highly chlorinated feed streams may generate corrosive conditions resulting from HCL gas within the off-gas oxidation exhaust stream, causing leaks in the system. The leaks may result in worker exposure via the inhalation/ingestion/dermal exposure routes.

Control: Controls for transfer systems include
- Use transfer equipment fabricated from materials that are chemically resistant to the chemical being transferred. Chemical resistance charts are available through the National Association of Corrosion Engineers (NACE).
- Consult Hydraulic Institute Standards HI 9.1-9.5 for appropriate materials for pumping various fluids.
- Train workers in potential acid exposure hazards and associated hazard controls.

CONTROL POINT: Design, Construction, Maintenance

(4) Toxic Discharge (Catalytic Oxidation Inefficiency).
Description: Poisoning/blinding of the catalyst with high metal and/or particulate loadings in the gas stream may decrease the catalytic oxidation efficiency of the system and increase the discharge of toxic wastes into the work and surrounding areas.

Control: Controls for toxic discharge include

- Monitor and control ash content of the waste feed to prevent excessive particulates from that source.
- Pre-treat air streams adequately to remove particulates using filtration, quiescent zone separation, or washing to prevent excessive particulates.
- Consider the metals content of the air stream in the design to avoid heavy metal poisoning of the catalyst.

CONTROL POINT: Design, Operations, Maintenance

c. Radiological Hazards.

No unique hazards are identified.

d. Biological Hazards.

No unique hazards are identified.